

Quarterly Report
July - September 1996

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Abstract

Our major achievements of this quarter were: (i) the completion of the MODIS cloud retrieval ATBD revision (version 4), (ii) participation in a July aerosol deployment known as TARFOX (Tropospheric Aerosol Radiative Forcing Observational Experiment), which includes a quick-look data processing system for use in the field, and (iii) the presentation (as group activities) of seven papers in the 1996 International Radiation Symposium and two papers in the SPIE calibration conference.

I. Task Objectives

With the use of related airborne instrumentation, such as the MODIS Airborne Simulator (MAS) and Cloud Absorption Radiometer (CAR) in intensive field experiments, our primary objective is to extend and expand algorithms for retrieving the optical thickness and effective radius of clouds from radiation measurements to be obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS). The secondary objective is to obtain an enhanced knowledge of surface angular and spectral properties that can be inferred from airborne directional radiance measurements.

II. Work Accomplished

a. MODIS-related Instrumental Research

After the new port 1 silicon array (with blue channel) was installed, the MAS was operated successfully in the TARFOX campaign, based at NASA Wallops Flight Facility during 10-30 July 1996. From the MAS quicklook images, we have confirmed that the blue channel behaved quite well as expected. Post-flight calibrations for TARFOX were performed at the Ames Research Center, analyses of which are currently underway. The Ames Calibration Lab (Pavel Hajek, engineer) is also researching a high temperature blackbody source for use in calibrating MAS, required to support biomass combustion studies. This would entail a small aperture blackbody whose output is expanded and collimated to fill the full input aperture of the MAS.

Ames (Jeff Myers) plans to upgrade the MAS in the Fall/Winter of 1996, including: (i) converting airborne recorders from Exabyte to hard disk, recording full 16-bit data, (ii) installing baseplate bolts to reduce thermal deformation, and adding temporary strain gauges to monitor structural behavior, (iii) adding a

continuous in-flight N₂ purge to the spectrometer to protect the internal optics from condensation, (iv) installing “descent mode” heaters to key areas (perhaps to include the primary and first folding mirrors), re-routing power from the blackbody controllers after data collection is finished, (v) adding an air flow barrier (boot) between the base of the scanhead and the superpod skin, (vi) thermally isolating the blackbodies from the scanner structure, to reduce cooling load on the overall system, (vii) finishing pre-flight scanner cart, which will ease handling of the scanhead (reduce risk of dropping) and allow more precise alignment of the 20” hemisphere during pre-flight, (viii) installing a temporary quartz window in the temperature chamber, and interfacing to the 20” hemisphere and collimator (more permanent installation to follow), and (ix) replacing the door seal and hinges on the chamber, and implementing water-purge procedures during tests.

The pre- and post-TARFOX calibration of the CAR was conducted by Tom Arnold using both the 48-inch integrating hemisphere and 6-foot sphere as the source. Additional tests (post-TARFOX) were done to investigate how repeatable the calibration is (day to day) and to investigate the stability of the offset values and significance of their differences for the different gain settings of each channel. Results thus far indicate good stability in both the radiance/voltage values as well as the offsets. Preliminary analysis suggested that pre-TARFOX calibration was successful. However, some problems were encountered with filter wheel channels, having been intermittently failing. Finally, channel 9 (1.64 μm) has gone dead. This problem is currently under investigation by Max Strange.

b. MODIS-related Data Processing and Algorithm Study

The MAS Level-1B data processing has been completed on MAS-50 data by Paul Hubanks for the Alaska-April and SCAR-B flights. This includes 10 flights from Alaska snow/ice mapping experiment (April 1995 in Alaska), 11 flights from SCAR-B (August-September, 1995 in Brazil), and 3 out of 10 flights from ARM-CAS (June 1995 in Alaska). Note that all data processed was Version-5 and will be replaced with Version-6. The reprocessing will include a new VIS/NIR calibration and a new set of (atmospherically corrected) Spectral Response Functions (SRFs). These new SRFs will affect the radiance calculation for all IR bands. In addition, a coding error of the emissivity correction was found in the processing of Version-5 data. This caused discrepancies in brightness temperatures of less than 0.5 °C in all port 3 and 1 °C in all port 4 channels. This has now been corrected in the MAS Level-1B processing software and will be implemented in all (upcoming) Version-6 MAS Level-1B HDF files. On the CAR data processing, Jason Li has completed HDF data sets for SCAR-B field experiment from flights 1688 to 1703 and finished SCAR-B CAR Flight Logbook.

Chris Moeller requested that several HDF Scientific Data Sets (SDS) should be added to the current MAS Level-1B HDF file structure. These included: (i) the MAS instrument temperature, allowing easy instrument temperature compari-

sons from different flights or within a given flight and (ii) the raw count value. Moeller also requested an analysis of the scaling factors used for packing and storing MAS radiance data (in an I*2 word) in the HDF file. The concern is that the radiance data might be stored to an accuracy that is smaller than the instrument noise. This could be a problem for channel 45, which is a low-noise channel that is used for high accuracy products like sea surface temperature. A compilation of typical radiance values for each channel is currently underway to make a determination if the scaling can be improved.

Ran Song (new member) completed the MODIS algorithm MOD_PR06OD Version-1 release-3 and closely worked with SDST staff on debugging the earlier release of the interface software. She also modified the MOD_PR06OD working environment after the new release of the Toolkit. Accordingly, Menghua Wang worked on the integration test for the MODIS cloud retrieval V1 code. Since the initial V1 code delivery to the SDST on 6 May, we have found and corrected a couple of core dump errors when running with MAS data for various pixel sizes. The final V1 package was re-delivered to SDST on 6 August and accepted by the Configuration Manager. Peter Soulen (new member) collected and studied five relevant MODIS ATBDs that describe Level-3 data products for MODIS-Atmosphere and is in the process of completing a summary of the output products so that more precise file specifications can be determined at the MODIS science team meeting.

c. MODIS-related Services

1. Meetings

1. Michael King, Tom Arnold, Jason Li, Xu Liang, Steve Platnick, Peter Soulen and Menghua Wang attended the MODIS Atmosphere group meeting in Chincoteague, Virginia on 17-18 July 1996 and the MAS calibration meeting at NASA Wallops Flight Facility on 19 July (also attended by Tom Arnold);

2. Tom Arnold and Steve Platnick attended the SPIE meeting in Denver, Colorado on 4-9 August 1996 and both presented paper there;

3. Michael King, Robert Pincus, Steve Platnick, Si-Chee Tsay and Menghua Wang attended the 1996 International Radiation Symposium in Fairbanks, Alaska on 19-24 August 1996 and King gave an invited talk on "Radiative properties of clouds determined from satellites" and the rest of them presented papers;

4. Michael King attended the 14th CERES science team meeting in Fort Collins, Colorado on 11-13 September 1996 and presented paper there.

2. Seminars

1. King, M. D., "Spectral absorption of solar radiation by clouds," JASON

Review, La Jolla, California, 1 July 1996.

2. Pincus, R., "What controls stratocumulus cloud fraction? Lagrangian observations of cloud evolution," University of British Columbia, Vancouver, Canada, 27 August 1996.

3. King, M. D., "Earth Observing System—Science Objectives and Challenges," Goddard Space Flight Center, Greenbelt, Maryland, 18 September 1996.

III. Anticipated Activities During the Next Quarter

a. Continue to work on the MODIS v2 cloud retrieval algorithm delivery;

b. Continue to analyze MAS, AVIRIS, and CLS data gathered during the ARM-CAS campaign, as well as AVHRR, University of Washington C-131A in situ data, and surface data, all with the express purpose of helping to develop the MODIS cloud masking algorithm;

c. Continue to analyze MAS, AVIRIS, and CLS data gathered during the US-Brazil SCAR-B campaign, as well as University of Washington C-131A in situ and radiation data to study aerosol-cloud interactions;

d. Continue to analyze surface bidirectional reflectance measurements obtained by the CAR during the Kuwait Oil Fire, LEADEX, ASTEX, SCAR-A ARM-CAS, and SCAR-B experiments, as well as analyze CAR diffusion domain data from MAST and FIRE-87;

e. Start to analyze MAS, HIS, and CLS data gathered during the NASA SUCCESS field experiment in Kansas from 8 April to 10 May 1996;

f. Attend the MODIS science team meeting (9-11 October) in College Park, MD;

g. Attend the FIRE meeting (17-18 October) in Boulder, Colorado;

h. Attend the SCAR-B science symposium (4-8 November) in Fortaleza, Brazil;

i. Finalize the MOD06 file specification for the MODIS v2 software delivery;

j. Design the file spec for the MODIS joint atmosphere level-3 product;

k. Incorporate a consistent set of quality assurance set of flags in all MODIS atmosphere data products.

IV. Problems/Corrective Actions

No problems that we are aware of at this time.

V. Publications

1. King, M. D., and M. K. Hobish, 1996: Satellite instrumentation and imagery. *Encyclopedia of Climate and Weather*, S. H. Schneider, Ed., Oxford University Press, 652–655.
2. King, M. D., W. P. Menzel, P. S. Grant, J. S. Myers, G. T. Arnold, S. E. Platnick, L. E. Gumley, S. C. Tsay, C. C. Moeller, M. Fitzgerald, K. S. Brown and F. G. Osterwisch, 1996: Airborne scanning spectrometer for remote sensing of cloud, aerosol, water vapor and surface properties. *J. Atmos. Oceanic Technol.*, **13**, 777–794.
3. Tsay, S. C., P. M. Gabriel, M. D. King and G. L. Stephens, 1996: Spectral reflectance and atmospheric energetics in cirrus-like clouds. Part II: Applications of a Fourier-Riccati approach to radiative transfer. *J. Atmos. Sci.*, **53**, 3450–3467.
4. Platnick, S., P. A. Durkee, K. Nielson, J. P. Taylor, S.-C. Tsay, M. D. King, R. J. Ferek and P. V. Hobbs, 1996: The role of background cloud microphysics in ship track formation. *J. Atmos. Sci.*, submitted.
5. Platnick, S. E., P. Abel and M. D. King, 1996: The effect of water vapor absorption on integrating sphere output radiance and consequences to instrument calibration, *Extended Abstract*, SPIE, Denver, Colorado, 4-9 August.
6. Arnold, G. T., M. Fitzgerald, P. S. Grant, S. E. Platnick, S. C. Tsay, J. S. Myers, M. D. King, R. O. Green and L. Remer, 1996: MODIS Airborne Simulator radiometric calibration. *Extended Abstract*, SPIE, Denver, Colorado, 4-9 August.
7. King, M. D., S. C. Tsay and P. V. Hobbs, 1996: Arctic Radiation Measurements in Column Atmosphere-surface System (ARMCAS). *Extended Abstract*, International Radiation Symposium, Fairbanks, Alaska, 19-24 August.
8. Pincus, R., M. D. King and S. C. Tsay, 1996: In situ measurements of the absorption of solar radiation in stratiform water clouds. *Extended Abstract*, International Radiation Symposium, Fairbanks, Alaska, 19-24 August.
9. Pincus, R., A. Marshak, A. Davis, M. D. King and W. J. Wiscombe, 1996: Diffusion domain retrievals of single scattering albedo inside thick but variable clouds. *Extended Abstract*, International Radiation Symposium, Fairbanks, Alaska, 19-24 August.
10. Platnick, S., E., 1996: The scales of photon transport in cloud remote sensing problems. *Extended Abstract*, International Radiation Symposium, Fairbanks, Alaska, 19-24 August.
11. Tsay, S. C., P. M. Gabriel, M. D. King and G. L. Stephens, 1996: Spectral reflectance and atmospheric energetics in cirrus-like clouds. *Extended Abstract*,

International Radiation Symposium, Fairbanks, Alaska, 19-24 August.

12. Wang, M., and M. D. King, 1996: Rayleigh scattering effects on cloud optical thickness retrievals. *Extended Abstract*, International Radiation Symposium, Fairbanks, Alaska, 19-24 August.